

National Aeronautics and Space Administration

Piloted Simulation of a Model-Predictive Automated Recovery System

James (Yuan) Liu, N&R Engineering
Jonathan Litt, NASA Glenn Research Center
T. Shane Sowers, Vantage Partners, LLC
A. Karl Owen, Consultant
Ten-Huei Guo, NASA Glenn Research Center

Aerospace Control and Guidance Systems Committee
Meeting No. 113
12-14 March 2014

www.nasa.gov

National Aeronautics and Space Administration

Contents

- Objective
- Methodology
- Test Bed
- Experiments
- Results
- Summary & Future Work

www.nasa.gov

National Aeronautics and Space Administration

Objective

- Loss-of-control situation during approach is particularly dangerous
- Aircraft is in a low-energy state (speed, altitude, propulsion)
- Proper energy management is crucial
- Model-predictive automated recovery system (MPARS): **prevent unintended/premature ground contact during approach phase of flight**
 - Automatic aggressive recovery maneuver if collision is otherwise inevitable
 - "Last-second" activation
 - Cannot interfere with proper landings

www.nasa.gov

National Aeronautics and Space Administration

Automatic Recovery System

The diagram illustrates the Automatic Recovery System. It shows an aircraft in a glide path (solid line) and a go-around flight path (dashed line). A horizontal line represents the altitude threshold. A dashed line above the threshold indicates the minimum altitude prediction for automatic go-around. The go-around path starts when the glide path crosses the minimum altitude prediction line.

- Define aggressive recovery control commands (e.g., autopilot GA mode, full power and pitch up, etc.)
- Continuous prediction of altitude loss due to maneuver
- If prediction violates threshold, initiate recovery maneuver

www.nasa.gov

National Aeronautics and Space Administration

Methodology

```

graph TD
    Start([GET CURRENT FLIGHT CONDITION]) --> Decision1{LANDING CRITERIA MET?}
    Decision1 -- YES --> Landing[DISABLE FLIGHT AND PROPULSION CONTROL  
OVERRIDE MODE FOR LANDING]
    Decision1 -- NO --> Predictor[FLIGHT PATH PREDICTOR]
    Predictor --> Decision2{ALTITUDE THRESHOLD VIOLATION?}
    Decision2 -- YES --> GoAround[TRIGGER FLIGHT AND PROPULSION CONTROL  
OVERRIDE MODE FOR GO-AROUND]
    Decision2 -- NO --> Start
    
```

www.nasa.gov

National Aeronautics and Space Administration

Methodology

```

graph TD
    Start([GET CURRENT FLIGHT CONDITION]) --> Decision1{LANDING CRITERIA MET?}
    Decision1 -- YES --> Landing[DISABLE FLIGHT AND PROPULSION CONTROL  
OVERRIDE MODE FOR LANDING]
    Decision1 -- NO --> Predictor[FLIGHT PATH PREDICTOR]
    Predictor --> Decision2{ALTITUDE THRESHOLD VIOLATION?}
    Decision2 -- YES --> GoAround[TRIGGER FLIGHT AND PROPULSION CONTROL  
OVERRIDE MODE FOR GO-AROUND]
    Decision2 -- NO --> Start
    
```

The flowchart is identical to the one in the previous slide, but the 'GO-AROUND' path (the 'YES' branch from the 'ALTITUDE THRESHOLD VIOLATION?' decision) is highlighted with a red circle.

www.nasa.gov





